STUDY ON THE NUTRITIONAL STATUS OF SOME SOILS UNDER DATE PALM CULTIVATION IN AL-HASSA OASIS

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ABSTRACT

Soil samples were collected from ten locations, covering area cultivated with date palms in the Al-Hassa Oasis. Physical and chemical properties of the samples were determined as well as available phosphorous, iron, manganese, copper, and zinc were estimated. The nutritional status was found to vary markedly from one location to another, though most of the soils exhibited deficiencies in available P, Fe, Mn, Cu, and Zn. The results are discussed in the lihgt of $CaCo_3$ content, soil pH and soluble salts.

Key words: Nutritional status, deficiencies, fertilization programmes.

INTRODUCTION

Al-Hassa Oasis is one of the largest irrigated areas in Saudi Arabia. The land is cultivated by traditional, methods producing dates, fruits, alfalfa and some vegetables (El-Khatib, 1974). Al-Hassa is the major date producer in the whole country. Most of Al-Hassa oasis has been under date palm cultivation for many centuries. Information regarding the nutritional status of soils under date palm cultivation is limited (Stewart-Jones and Kelso, 1977; Bashour et al., 1983; Devi Prasad et al., 1984; Al-Barrak, 1986).

The objective of this study is to collect information regarding the nutritional status of soils that are under date palm cultivation. It may help to offer a fertilization programme in order to increase date yield in the oasis.

MATERIALS AND METHODS

Soil Sampling

The sites were chosen to cover most of the area cultivated with date palms throughout the oasis. Figure 1 shows the location of the different sites. Two samples were collected from each site to represent the soil layer i.e., 0 - 0.30m and 0.30 - 0.60m.

Methods of Analysis

Air dry soil samples were ground to pass through a 2 sieve, and then pH, electrical conductivity (EC), total carbonates and soluble cations and anions were determined (Richards, 1956). Mechanical analysis was made by the hydrometer method (Fath *et al.* 1976). Organic matter, total nitrogen and available phosphorus according to Black *et al.* (1965). Gypsum was determined according to Elprince and Turjoman (1983). Available micronutrients (Fe, Mn, Zu, and Cu) were determined according to Lindsay and Norwell (1978).

RESULTS AND DISCUSSION

Physico-chemical Properties

Table 1 shows the physico-chemical properties of the soil samples. The salinity of the soils ranged between a very low value (EC = 1.6 dS m^{-1}) to a moderate one (EC = 8.2 dS m^{-1}). The dominance of soluble cations follows the order $Na^+ > Ca^{2+} > Mg^{2+} > K^+$, while that of the soluble anions follows the order $Cl^- > HCO_3^- > SO_4^{2-}$ with the absence of CO_3^{2-} ion in all the samples. Soil pH ranged between 7.7 and 8.4. All the soils are calcareous having an average $CaCO_3$ content of 19.9%. Gypsum content varied between 0.1% and 1.2%. The particle size distribution of the soil samples showed that they had a coarse texture, the sand fraction exceeded 47% while clay fraction hardly reached 30% except in one single sample in which it had a value of 33%.

Nutritional Status

Organic matter, total nitrogen, and the available nutrients were determined (Table 2). The data for sulphur in the form of sulphate ion is presented in Table 1.

Nitrogen and sulphur

Total nitrogen in all soil samples was very low, having a maximum value of 0.12%. Total nitrogen represents all forms of nitrogen present in the soil regardless of its source whether organic or mineral. In order to determine the source of nitrogen in the soil, total nitrogen values were plotted against organic matter content (Figure 2) where a straight line relationship was found with r value of 0.9514**. It is clear from the figure and the regression equation (Total N% = 0.055 O.M.%) that the straight line passes through the origin which means that organic matter is the only source of nitrogen. Then either farmers did not apply nitrogen fertilizers to their soils or it was leached away *via* irrigation. Both organic matter and total nitrogen have higher values in the upper layers than in the lower ones. This is due to the application of manure and/or plant residues on the soil surface.

Sulphur is absorbed by plant roots in the form of sulphate ion. Sulphate ion concentration is relatively high in the soil solution of all soil samples, except for two of them representing the site 5. Irrigation water also contains a high concentration of sulphates. Chemical composition of irrigation water used in Al-Hassa Oasis is given in Table 3.

An insignificant correlation coefficient (r = -0.3282) was found between gypsum content and sulphate ion concentration. This indicates that gypsum is not the only source of soluble sulphate in the soil solution, probably irrigation water also is a major source of sulphur.

Phosphorus

Plants absorb phosphorus from solutions in proportion to the concentration of phosphate ions in the solution. Further, if other factors are not limiting, growth will be proportional to the amounts of phosphorus absorbed by the plant. According to Black *et al.* (1965) the critical level of phosphorus is 5 mg kg^{-1} P, while soils contanining 5-10 mg kg^{-1} may respond to phosphortis fertilizers. If the soil contains more than 10 mg kg^{-1} P it will not respond to phosphatc fertilizer. In view of the above, the phosphorus level in the soils studied ranges between low and

Table 1. Physico-chemical properties of the soils.

Sample* No.	EC $dS\,m^{-1}$	pH	Soluble cations and anions ($mol\,m^{-3}$) (saturation extract)								Gypsum %	$CaCO_3$ %	Particle size distribution %		
			Na^+	K^+	Ca^{2+}	Mg^{2+}	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}			Sand	Silt	Clay
1 a	6.0	7.7	15.7	1.0	15.1	9.6	0.0	6.5	17.5	20.9	1.2	28.3	57	26	17
1 b	4.3	7.3	18.3	1.0	13.2	4.4	0.0	4.0	25.2	12.7	0.6	28.9	55	26	19
2 a	3.6	7.8	17.0	1.0	6.0	5.1	0.0	7.1	20.0	6.5	0.3	19.3	69	16	15
2 b	2.9	7.8	15.7	1.0	5.1	3.7	0.0	4.2	19.8	4.9	0.5	32.1	57	20	23
3 a	3.4	7.7	17.8	1.0	5.9	11.7	0.0	7.6	25.1	10.7	0.7	23.5	66	19	15
3 b	2.2	7.8	11.7	0.8	5.2	2.1	0.0	4.1	15.2	3.5	0.2	6.2	89	4	7
4 a	3.4	8.1	15.7	1.3	6.1	4.1	0.0	11.3	20.1	3.0	0.5	12.8	79	10	11
4 b	3.5	8.0	17.8	1.5	5.2	4.0	0.0	5.0	25.3	3.7	0.1	14.1	71	18	11
5 a	1.5	8.2	8.7	1.0	3.2	2.6	0.0	7.2	14.5	0.2	0.4	11.4	73	20	7
5 b	1.6	8.1	7.8	0.8	3.1	2.2	0.0	6.7	14.4	0.2	0.2	7.8	91	4	5
6 a	2.5	8.4	13.5	0.5	4.5	2.9	0.0	6.0	15.3	4.0	0.5	23.3	65	22	13
6 b	2.5	7.9	10.9	0.8	5.1	2.1	0.0	5.4	15.1	2.6	0.7	25.1	61	22	17
7 a	2.2	8.3	8.7	0.5	3.6	2.6	0.0	7.3	12.4	0.9	0.6	24.4	53	28	19
7 b	1.7	8.0	9.1	0.5	4.3	4.3	0.0	8.1	15.1	1.3	0.5	19.7	59	8	33
8 a	7.0	8.0	33.5	1.5	13.2	7.1	0.0	6.0	47.7	10.8	0.7	17.3	73	16	11
8 b	8.2	7.9	32.2	1.8	11.7	20.4	0.0	5.2	44.9	23.5	0.3	21.7	65	16	19
9 a	2.5	8.1	11.3	0.8	3.6	8.1	0.0	6.6	14.8	6.8	0.4	31.4	49	28	23
9 b	2.2	8.4	10.9	0.8	4.2	7.7	0.0	5.4	14.7	7.1	1.1	16.0	47	26	27
10 a	7.8	8.2	35.2	1.8	13.3	11.8	0.0	5.5	47.5	16.6	0.3	15.9	75	13	12
10 b	6.4	8.3	23.9	1.5	15.1	6.1	0.0	4.4	27.5	17.7	0.7	18.5	67	20	13

* a: Upper soil layer (0-0.30m) and b: Lower soil layer (0.30 - 0.60m)

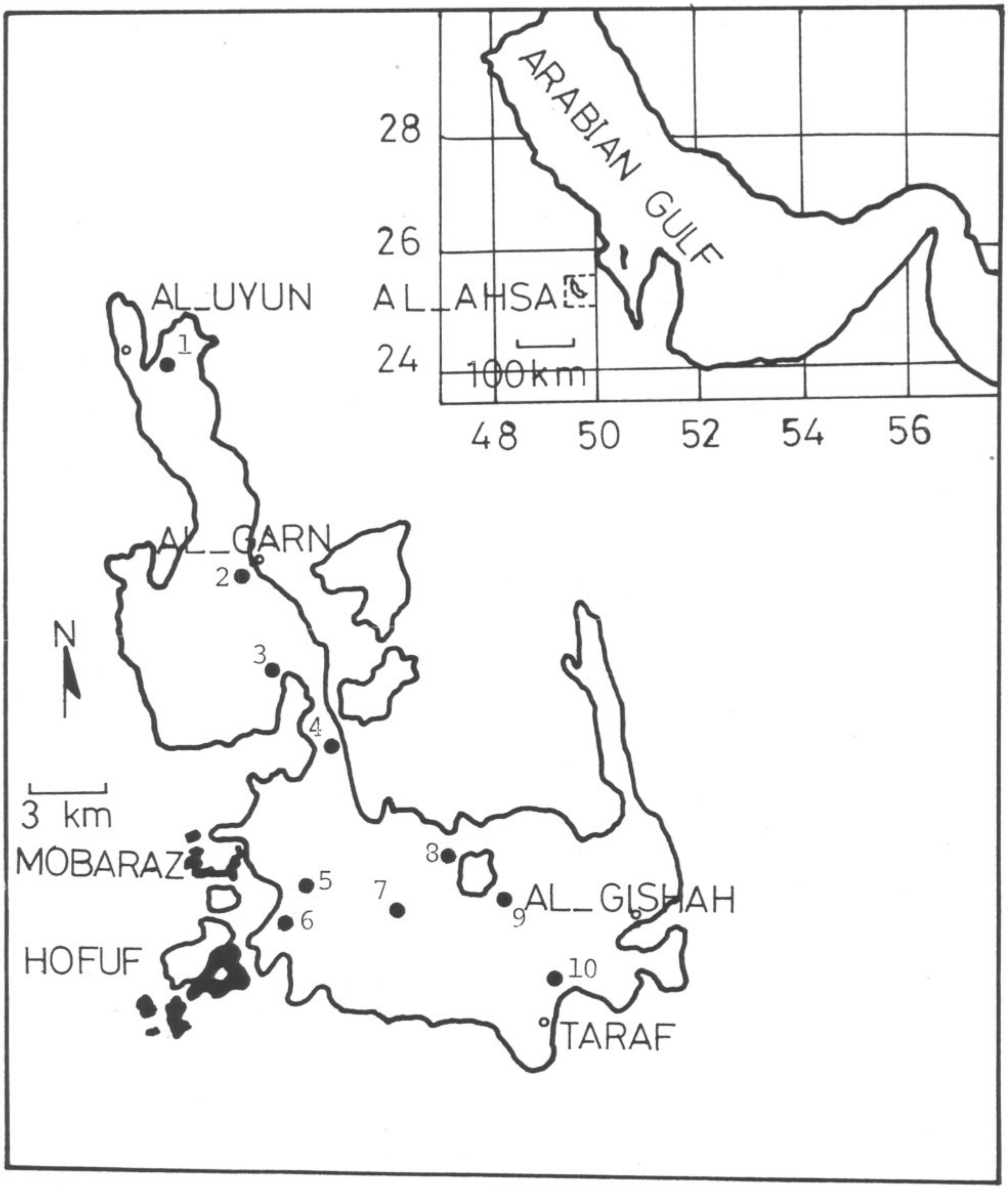

Figure 1 . Locations of the sampling sites in Al-Hassa oasis.

moderate, with only a few soils which can be considered to be rich in available phosphorus, i.e. sites 1,2, and 4.

In arid regions available phosphorus is usually affected by $CaCO_3$ and pH. Therefore, the relationship between available

Table 2. Organic matter content and available nutrients

Site No.	O.M. %	Total N %	Available nutrients (mg kg^{-1})				
			P	Fe	Mn	Cu	Zn
1 a	1.89	0.12	69.1	10.5	3.0	0.5	1.2
1 b	1.09	0.06	18.3	3.5	3.3	0.5	0.9
2 a	1.43	0.08	21.2	3.9	4.7	0.5	3.0
2 b	1.10	0.05	9.3	5.0	6.1	0.4	1.2
3 a	1.25	0.07	4.9	4.3	3.8	0.5	1.5
3 b	0.22	0.01	3.1	6.7	3.2	0.7	1.6
4 a	2.16	0.11	29.4	6.0	5.1	0.7	1.3
4 b	0.84	0.03	6.0	3.3	2.1	0.5	1.0
5 a	0.71	0.03	4.9	8.2	4.9	0.7	1.5
5 b	0.29	0.02	3.7	9.0	2.8	0.7	1.0
6 a	1.28	0.07	10.6	5.2	3.0	0.5	2.1
6 b	0.64	0.03	7.0	3.9	3.4	0.7	1.2
7 a	2.02	0.11	6.2	3.7	6.7	0.5	1.4
7 b	1.38	0.08	5.4	2.6	5.4	0.5	1.3
8 a	0.96	0.08	7.2	3.0	4.7	0.7	1.3
8 b	0.61	0.03	4.5	2.0	3.2	0.7	1.3
9 a	1.91	0.09	0.6	2.8	2.2	0.5	1.2
9 b	1.63	0.09	8.7	2.6	2.3	0.5	1.3
10 a	1.17	0.06	5.6	2.2	1.9	0.5	1.2
10 b	0.88	0.05	6.4	1.6	1.1	0.5	1.0

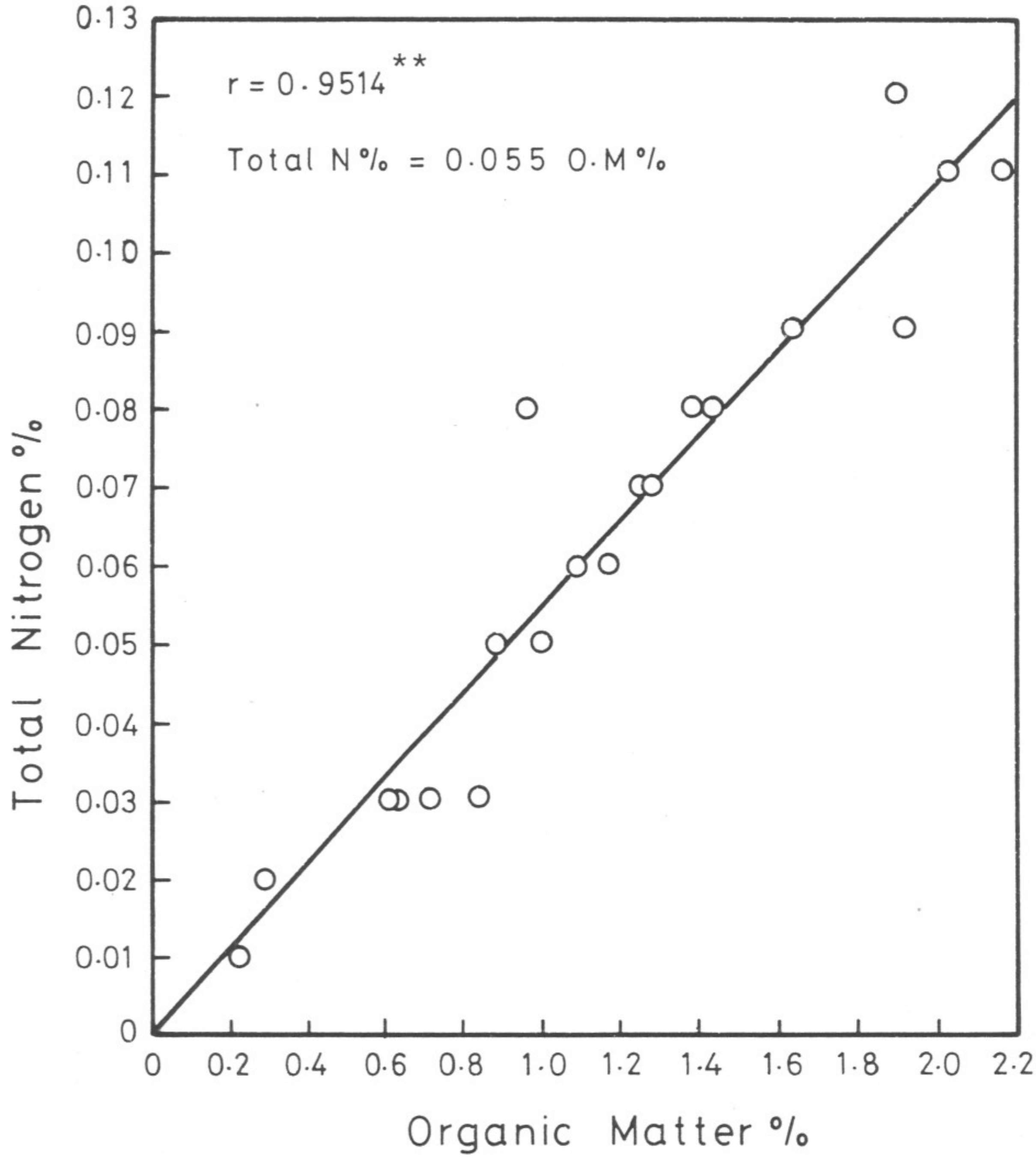

Figure 2 . The relationship between organic matter and total N% in the investigated samples

phosphorus and $CaCO_3$ content or pH was tested through the calculation of their simple correlation coefficients. The result showed no significant correlation. This gives an indication that some soils receive phosphorus fertilizers while others do not.

It is well known that most of the farmers of Al-Hassa apply either cattle or chicken manure to their farms and few of them apply NPK fertilizers (18-18-15) in the form of urea, superphosphate and potassium sulphate, respectively. If this is the case, we should expect soils having a high P level to contain high levels of both N and K which is not the case in the soils investigated (Table 2). This may be explained as follows:

On the application of the compound fertilizer both urea and potasium sulphate dissolve in the soil solution and after one or two irrigation periods they are leached away because of the coarse texture of the soil. On the other hand, super-phosphate granules (monocalcium phosphate) when dissolved in the soil form a concentrated solution having a pH of 1.8. This solution is precipitated as dicalcium phosphate on the surface of calcium carbonate particles. Phosphate ions also may react directly with calcium ions in the soil solution to form dicalcium phosphate (Tisdale and Nelson, 1975). Dicalcium phosphate is less soluble and hence it is retained in the layers of the soil.

Micronutrients

Critical levels of micronutrients in cal-

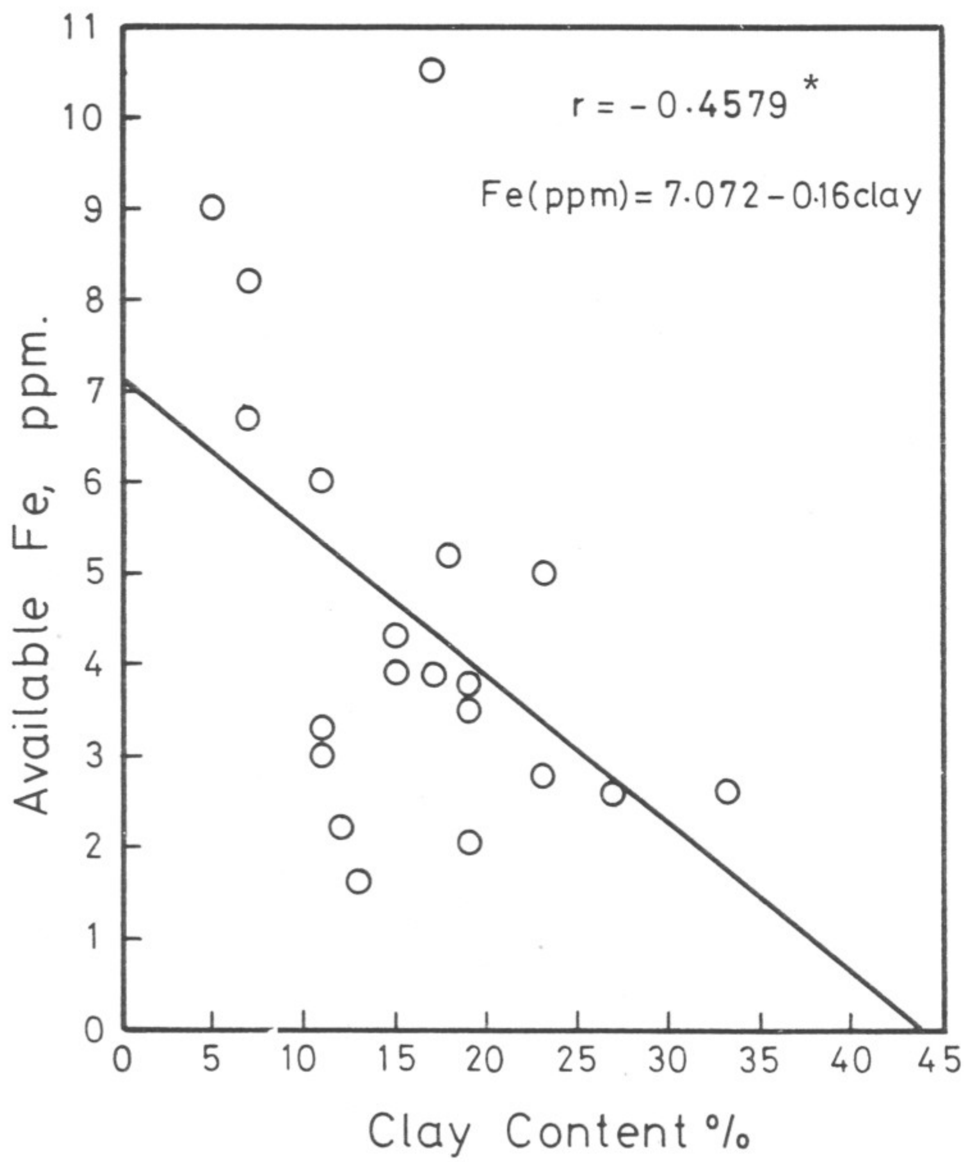

Figure 3 . The relationship between clay content and available Fe in the investigated samples

Table 3. Chemical composition of irrigation water*

EC ds.m^{-1}	Soluble cations and anions mol m^{-3}								Water type
	Na^+	K^+	Ca^{2+}	Mg^{2+}	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	
2.29	13.0	0.2	3.7	2.1	0.0	3.1	14.7	3.7	C_2-S_2

* after asseed *et al.* (1982)

careous soils have been given by Lindsay and Norwell (1978). Expressed in mg kg^{-1}, these are 4.5 for Fe, 1.0 for Mn, 0.2 for Cu, and 0.8 for Zn. Most of the soils under investigation show a deficiency in Fe which was reported by Stewart-Jones and Kelso (1977), Bashour et al. (1983) and Devi Prasad et al. (1984). Iron is retained on clay surfaces and a negative relationship exists between clay content and available Fe. Such a relationship is shown in Figure 3. As expected, a negative correlation coefficient was found ($r=-0.4579^*$). For both Mn and Zn, most of the soils are above the critical level. Bashour et al. (1983) and Devi Prasad et al. (1984) have reported deficiencies in Mn and Zn in some soils of Hofuf. No Cu deficiency was found in the soils under investigation or reported in the literature for the same area.

It is important to indicate that the critical levels reported by Lindsay and Norwell (1978) were given for only two crops, i.e. sorghum and corn grown on calcareous soils from Colorado, U.S.A. It is recommended that research should be carried out to examine the critical levels of micronutrients under the conditions of Saudi Arabia, especially for date palms and other local crops.

RECOMMENDATIONS

In view of the above discussion, it is clear that most of the soils under date palm cultivtion suffer from one or more of the essential nutrients. Therefore, it is recommended that farmers should apply manure to their soils rather than applying mineral fertilizers especially N and K. The application of sulphur would also help in increasing the availability of nutrients especially phosphorus.

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دراسة عن المستوى الغذائي لبعض أراضى واحة الأحساء المنزرعة بالنخيل

محمود خفاجى ، يوسف عبد الهادي و سعد البراك

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الخلاصـــة

لقد تم جمع عينات تربة من عشرة مواقع شاملة لمعظم المساحات المنزرعة بالنخيل في الواحة. كما تم تقدير كل من الخواص الكيمائية والطبيعية لهذه الأراضي إضافة للمتيسر من الفسفور، الحديد، المنجنيز، النحاس والزنك. حيث وجد أن المستوى الغذائى يتغير بجلاء من موقع إلى آخر على الرغم من أن معظم الأراضى المدروسه أظهرت نقصا في الصور المتيسرة من هذه العناصر. هذا ولقد تمت مناقشة النتائج فى ضوء محتوى التربة من كربونات الكالسيوم والأملاح الذائبة وكذلك رقم الحموضة.

الكلمات الدليلية : المستوى الغذائى، نقص الصور المتيسر، برامج التسميد.
